



# The Antarctic Seismographic Argentinean Italian Network - ASAIN

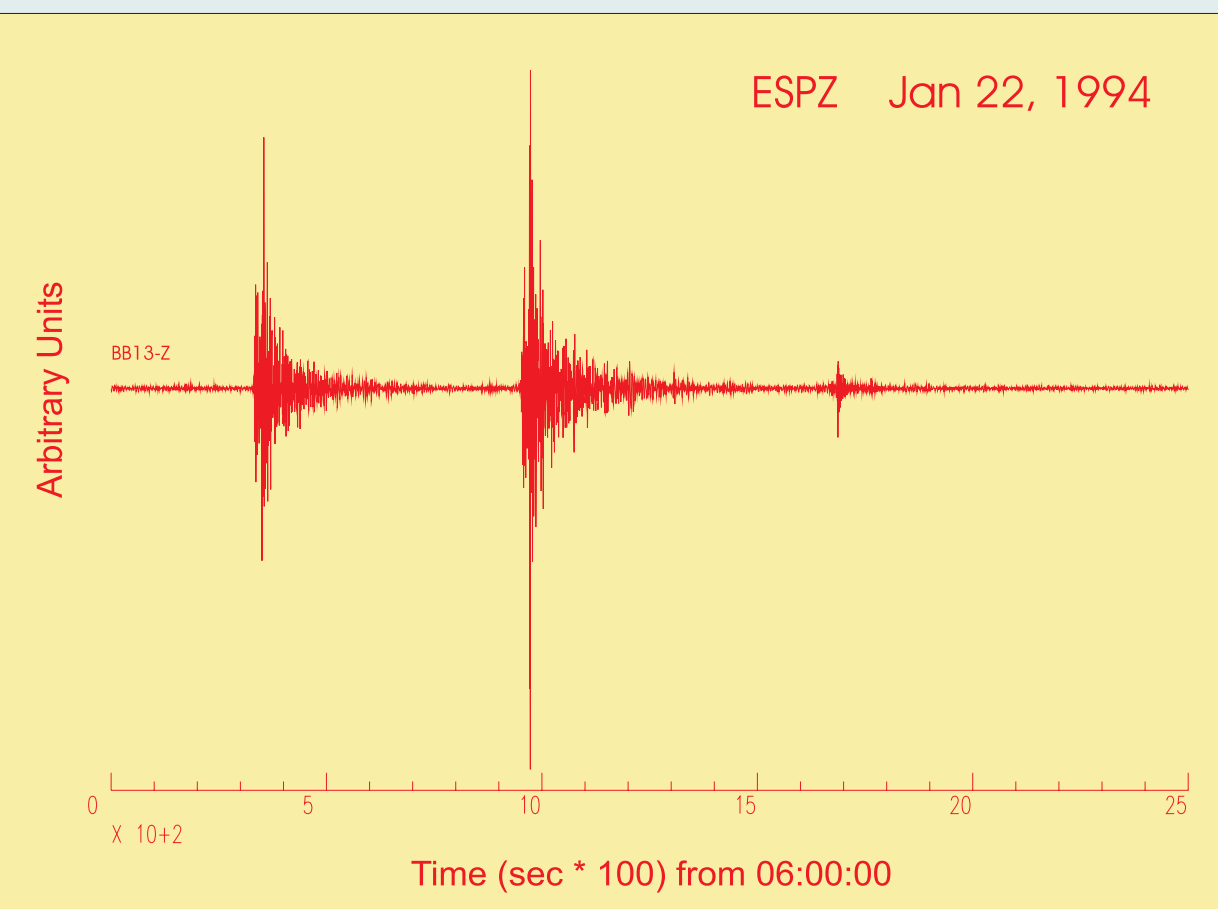
## Improving the instrumental coverage in Antarctica

Marino Russi, Claudio Cravos, Damiano Pesaresi & Milton P. Plasencia L.

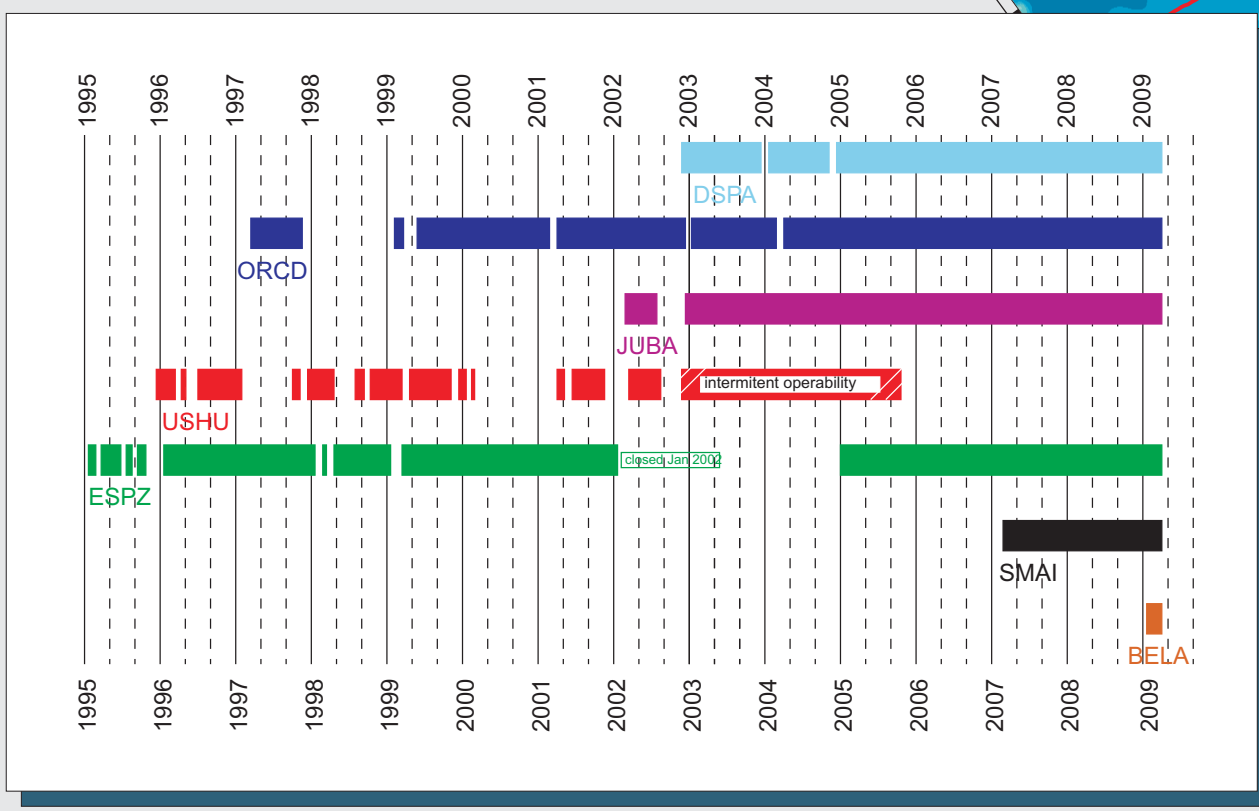
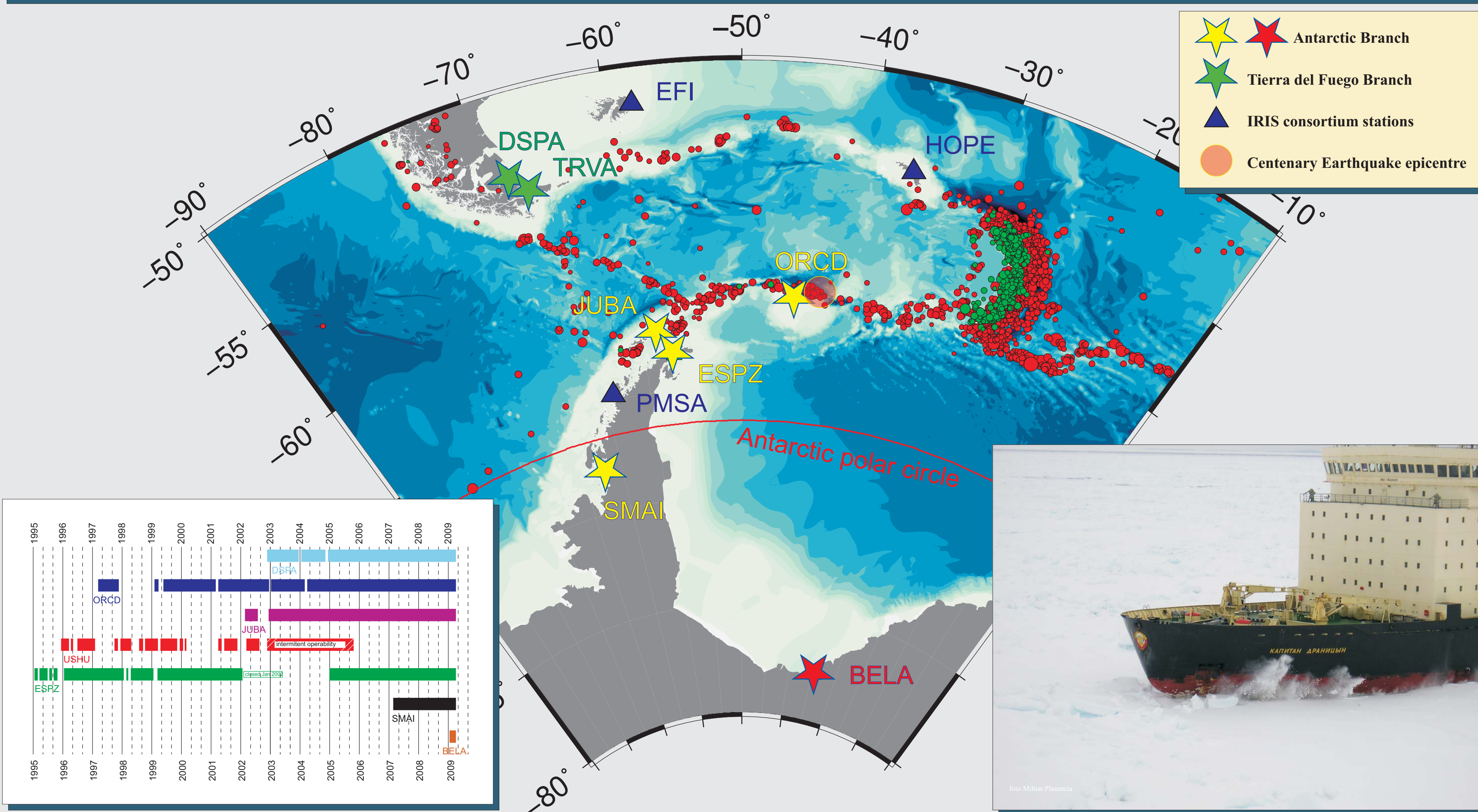
Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - OGS



**Abstract:** Scientific investigations of the Scotia Sea region are crucial to understand the history of the Antarctic continent tectonic evolution and the influence of the aperture of the Drake passage in establishing the Circumpolar Antarctic Current, as stressed by many authors (e.g. Lodolo, 2008). The Scotia Sea occupies a roughly rectangular area of about 900,000 km<sup>2</sup>. This area is limited on three sides by the Scotia Arc, formed by islands and oceanic ridges, which is a remnant of the mountain chain that joined the South American Andes to the Antarctic Peninsula. The western border is represented by the about 1000 km wide Drake passage, that separates today the Tierra del Fuego in South America from the Antarctic continent. A review of the tectonics and evolution of the Scotia Sea can be found in Barker, 2001. The start of the geophysical studies in this area dates back to several decades ago, but only after 1990 instrumental passive seismology started to be widely applied to investigate the crustal properties and the properties of the seismic sources responsible for the strong seismicity level observed along the Scotia plate boundaries. ASAIN started operation in 1992 when a temporary seismograph was installed at the Argentinean Base Esperanza. It grew quickly during the nineties and today five stations are operated in Antarctica and two in Tierra del Fuego. All the Antarctic stations transmit real-time data to the OGS and to the Instituto Antartico Argentino. Esperanza (ESPZ), Jubany (JUBA), San Martin (SMAI) and Orcadas(ORCD) stations also participate in the Virtual European Seismographic Broadband Network (VEBSN) transmitting real time data to the Orfeus Data Centre. On January 16<sup>th</sup>, 2009 BELA station was added to the network. It is operated at the southernmost Argentinean Base Belgrano II (77° 52' S, 34° 37' W) located on a rocky outcrop (Nunatak Bertrab) on the Filchner barrier. Its inclusion in the VEBSN is also planned. ASAIN data real-time acquisition is performed using SCREAM software, but also Earthworm and Antelope software are being tested at the OGS Seismological Research Centre.



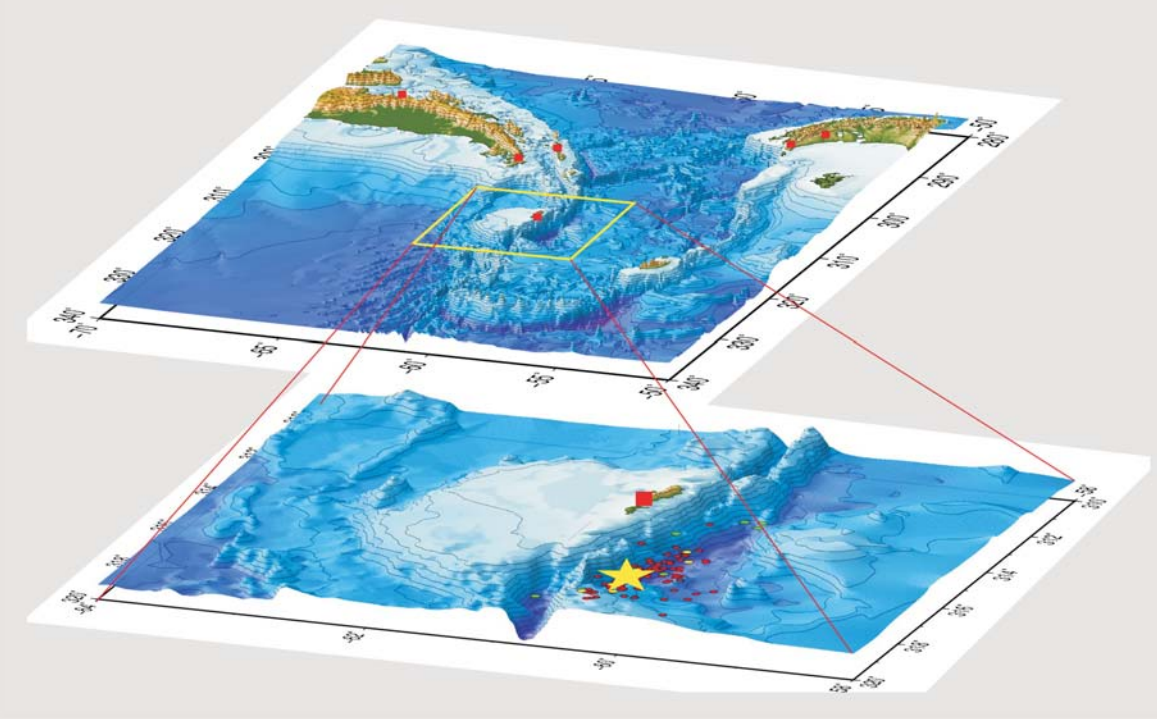
## Antarctic Seismographic Argentinean Italian Network Location Map



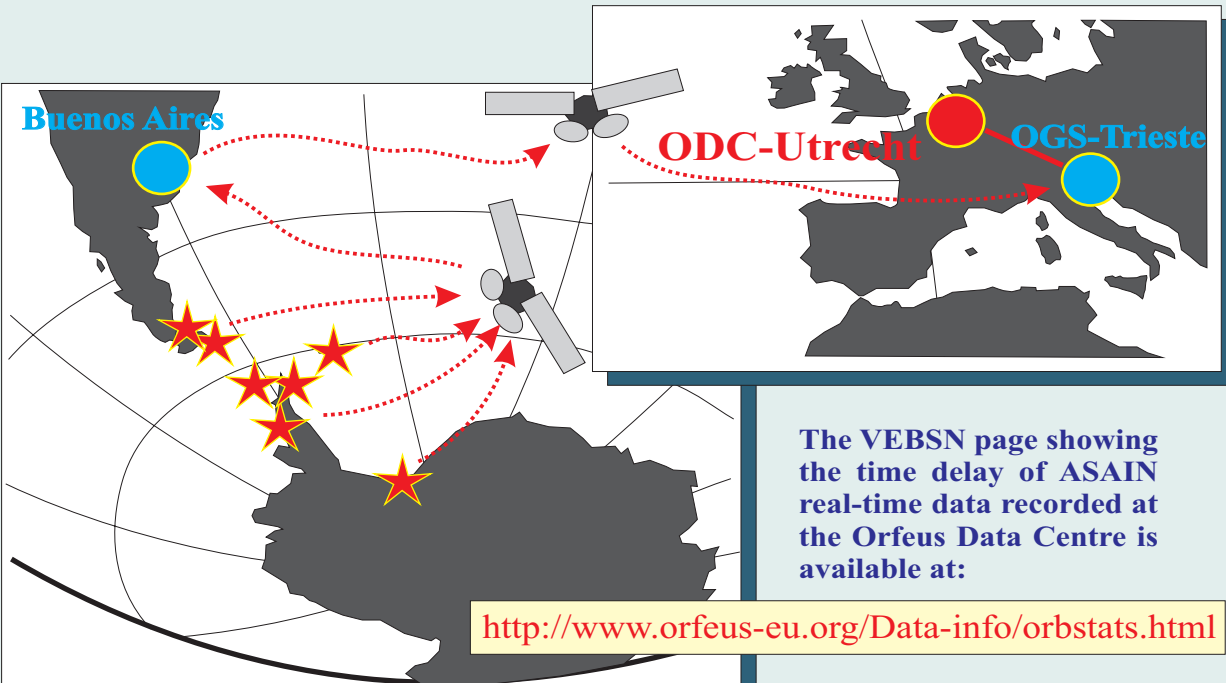
### ASAIN: History (1992-2005).

With the initial objective of defining a site for the possible installation of a permanent seismographic station in the Scotia sea region oriented to the study of the geodynamics and of the structural properties of the lithosphere there, the PNRA/OGS and the DNA/IAA installed and operated jointly a temporary station at the Antarctic Argentinean base Esperanza. The temporary seismograph started recording on Jan 20<sup>th</sup>, 1992 and it was operated during three years allowing the Italian OGS and Trieste University researchers, together with the Instituto Antartico Argentino (IAA) partner seismology group, to obtain useful information on the regional seismicity. At the beginning of 1995 it was upgraded to a permanent seismological observatory. Between the end of 1995 and the beginning of 1997 two similar installations were put into operation at Ushuaia (La Pataia Bay, Tierra del Fuego, Argentina) and Orcadas Base on the Laurie Is (South Orkney Is.). The data collected by the three stations have been used to perform some preliminary investigation on the lithospheric structure of the Scotia Sea region by means of surface wave dispersion analysis. These results represented the guideline for the definition of the most suitable seismological algorithms to be used in the data processing and interpretation. Similarly advanced methodologies have been developed and applied by the OGS and Trieste University researchers to the analysis of regional earthquakes in the area. The ASAIN was further expanded in 2002 when ESPZ (Estancia Despedida, Tierra del Fuego, Argentina) and JUBA (Base Jubany, South Shetland Is.) started operation. (Russi et al., 2004). The year 2003 represents a benchmark in the development of the network. During the austral summer OGS researchers started testing satellitar connections between the Orcadas station and the OGS using Inmarsat satellitar phones. The following year the IAA provided the ASAIN with satellitar and Internet links to be used for remote communication between the OGS and the Antarctic stations. The availability of these facilities allowed a quick upgrade to real-time data communication and remote control of the functionality of the instrumentation in the ASAIN sites. As a consequence between 2003 and 2005 ORCD, ESPZ and JUBA stations started remote real-time data acquisitions at the OGS in Trieste on a data server managed by the OGS Seismological Research Centre personnel. The server was in turn linked with the IAA and the ORFEUS Data Centre allowing the inclusion of the ASAIN among the contributors to the Virtual European Broad-band Seismic Network (VEBSN). The dataset obtained with the 5 station ASAIN configuration and the neighbouring GSN stations EFI (East Falkland Is.), HOPE (South Georgia Is.) and PMSA (Palmer Station) was then extensively exploited. The dataset permitted to obtain smoothed local dispersion curves in correspondence of the main geological and tectonic features, and through their non-linear inversion, the average S-wave velocity versus depth profiles in the sub-Antarctic Scotia Sea region by means of surface-wave tomography techniques (Vuan et al., 2000). The results obtained both with synthetic experiments and observed data inversions encouraged the systematic application of this methodology, in the perspective of focusing the study on low-level seismicity detected by temporary arrays in Antarctic Peninsula and Tierra del Fuego.

### South Scotia Sea: August 04, 2003 04:37:19 The South Orkney Is. Centenary Earthquake



A major earthquake, 7.6 magnitude shook the S.Orkney Is. and the whole Scotia Sea area on August 4<sup>th</sup>, 2003 at 04:37:19 GMT along the Scotia Sea-Antarctic Plate margin. The epicentre was located along the South Scotia Ridge at Lat. 60°55' S, Lon 43°49' W, 70 km to the North-West from the Argentinean base Orcadas. The aftershock sequence that followed lasted for more than one year and several thousands of events were recorded by ORCD station. About twenty aftershocks exceeded magnitude Mb 5.0 and were recorded by the whole ASAIN. The main event, which was nicknamed "Centenary Earthquake" because it happened exactly one hundred year after the foundation of Orcadas base, caused minor damages to the base structures but no casualties among the Argentinean personnel. Several ice falls from the mountains surrounding the base were observed but the most astonishing visible effect was represented by the large fractures in the ice pack surrounding the island showing vertical displacements reaching 2 m amplitudes.



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### The Seismological PNRA-OGS/DNA-IAA contribution to the IPY: SMAI (San Martin) and BELA stations (Belgrano II)

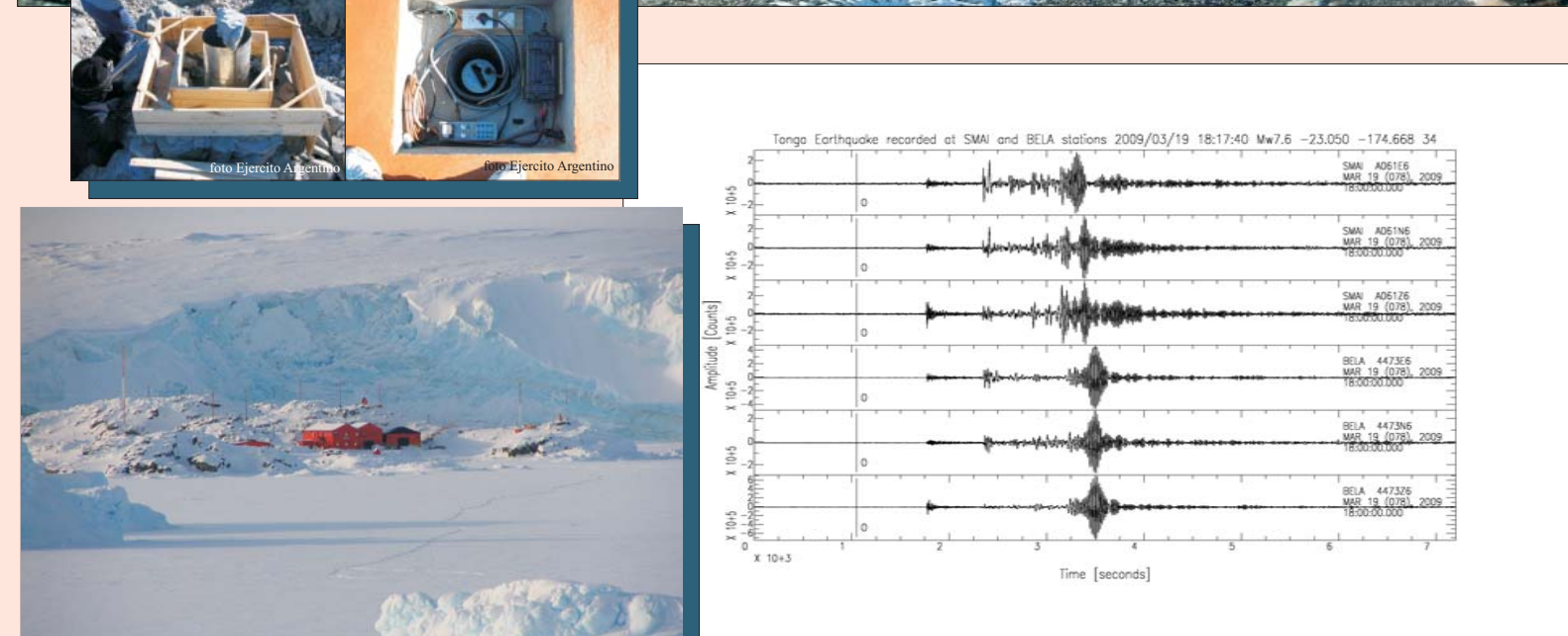
At the end of the 2005 campaign after completing the upgrade to real-time mode of operation of the Antarctic ASAIN stations a further ASAIN improvement and the extension of its geographic coverage to the south of the antarctic polar circle was planned by the Italian and Argentinean antarctic programmes as a common contribution to the activities of the International Polar Year. The project was actuated in two steps: On February, 2<sup>nd</sup>, 2007 SMAI station, the first ASAIN site located beyond the polar circle, started operation at the Antarctic Argentinean Base San Martin, while BELA station was opened at Belgrano II base on January 16<sup>th</sup>, two months before the end of the IPY activities by the italo-argentinean group after a difficult approach to the Argentinean base on board the Russian polar vessel Vasily Golovnin.

#### San Martin - SMAI

Located immediately south of the southern polar circle (Lat: 68° 08' S, Lon: 67° 06' W) on Barry Is., a small island in the Margarita Bay, between the big islands Belgrano and Alejandro I, the permanent Argentinean Base San Martin was inaugurated on March 21st, 1951. The base, managed by the personnel of the Argentinean Comando Antartico del Ejercito is surrounded by awesome glaciers which descend from the Pacific side of the Antarctic Peninsula directly to the sea. The temperatures vary between a maximum of 8° C in the summer to minima around -37° during the winter with winds that reach velocities above 200 km/h. The scientific activities hosted in the base include Geodesy, Oceanography, Glaciology and Seismology. SMAI ASAIN station started recording on February 2<sup>nd</sup>, 2007. The broad-band seismograph is based on a Güralp CMG-3T sensor recording locally 40, 20 and 2 samples/sec three component (Z, E-W, N-S) broad band continuous seismic channels. 20 and 2 samples/sec channels are also sent in real-time to the OGS and the IAA using a satellitar connection and SCREAM networking software. Each night the complete 24 hour 40, 20, and 2 sample/sec data set recorded during the previous day is retransmitted to the OGS server used to archive ASAIN data. SMAI station also contributes its 20 and 2 samples/sec real-time data channels to the VEBSN. During the Antarctic summer the ice movement causes a lot of icequakes to be recorded.



**SAN MARTIN**  
Lat. 68°08'S, Lon. 67°06' W



#### Belgrano II - BELA

Located at Lat. 77° 52' 29" S, Lon. 34° 37' 37" W on a granitic outcrop on the Filchner barrier, Base Belgrano II, the most austral Argentinean permanent scientific station - 1350 km about from the South Pole - was inaugurated on February 5<sup>th</sup>, 1979. The base, managed by the personnel of the Argentinean Comando Antartico del Ejercito, occupies an area of about one hectare emerging from the ice on the top of Nunatak Bertrab. The temperature varies between a mean maximum of 0° C in the summer to minima around -54° during the winter with strong winds which sometimes reach velocities above 200 km/h. The scientific activities hosted in the base include Geodesy, measurements of atmospheric ozone and solar radiation, Astronomy and Seismology. The seismographic station is based on a Güralp CMG-3ESPC seismometer. 40, 20 and 2 samples/sec three component continuous data are recorded both locally and in real-time at the OGS and the IAA. In the next future BELA station will be included in the VEBSN. It is to be noted that only QSPA station is operated at a lesser distance from the South Pole.



**Belgrano II**  
Lat. 77°52' S Lon: 34°37' W.

### Conclusions

The Antarctic Seismographic Argentinean Italian Network (ASAIN) is an excellent tool for the acquisition of high quality seismometric data to be used by scientists interested in using modern seismological approaches to the investigation of the regional geodynamic and structural characteristics of the Scotia Sea. Its database integrated with data recorded by some other stations operated in the Scotia Sea and nearby areas by other international institutions allowed a considerable progress in the knowledge of the structural and geodynamic properties of the crust and upper mantle in the region. Born in 1992, when ESPZ station was opened, it grew progressively to today configuration which includes seven three component broad band stations. Five stations are located in Antarctic Argentinean permanent bases while two more are operated in the Argentinean Tierra del Fuego. The instrumental equipment has been subject to a continuous upgrade, and during 2003 the conversion of ASAIN from local recording to remote real-time data acquisition using satellitar lines and Internet provided by the Argentinean partneret started. At the moment all the ASAIN Antarctic stations (ESPZ, JUBA, ORCD, SMAI, BELA) contribute real-time data to the VEBSN via the OGS where the network operation is continuously monitored realizing also a relevant contribution to the global seismographic network in a formerly uncovered region.

**Acknowledgments.** The ASAIN is a cooperation project between the Italian-PNRA and the Argentinean DNA-IAA. The "Broad-band seismology, lithospheric structure and geodynamics in the Scotia Sea region" project is funded by the Programma Nazionale di Ricerche in Antartide (PNRA), research area 2: "Geodesia ed Osservatori". A grateful acknowledgment is directed to the Argentinean civil and military personnel who operates the ASAIN stations in Antarctica, to the crews of the Argentinean vessels ARA "Almirante Irizar" and "Puerto Deseado" and of the Russian ships "Kapitan Dranitsyn" and "Vasily Golovnin". The authors are grateful to Riccardo Lungwirth for his contribution in the preparation of this poster. We want also to remember here our friend José Febrer, who suddenly died on May 2<sup>nd</sup>, 2008. José participated together with Marino Russi, Daniel Nieto and Francesco Fanzutti to the installation of the first ASAIN station in Esperanza, and, since then, has been our main reference at the Instituto Antartico Argentino for all the activities concerned with the ASAIN network. We will always miss him.

